Pathological Changes in the Lumbar Spine of Pigs: Gross Findings

C. E. Doige*

ABSTRACT

The lumbar vertebral columns from 60 sows and 30 slaughter weight pigs were examined grossly for pathological changes. Asymmetry of lumbar articular facets and minor periarticular osteophytes were seen in the slaughter weight group. Degeneration of intervertebral discs or vertebral osteophytes were not present. In contrast, 38% of 60 sows had vertebral osteophytes and 40% had degeneration of intervertebral discs. Extensive ankylosing spondylosis was present in two sows. Other vertebral lesions observed in sows include asymmetry and arthrosis of articular facets, fissures and areas of cavitation in the annulus fibrosus and vertebral end plate, and vertebral osteomyelitis and/or vertebral fracture. Extravertebal skeletal lesions, some of which could be related to a clinical history of lameness or posterior paralysis, include sacroiliac arthrosis, pelvic deformity, polyarthritis, femoral osteomyelitis, sacroiliac dislocation and epiphyseolysis involving the femoral head or tuber ischii.

RÉSUMÉ

Cette étude visait à rechercher la présence de lésions macroscopiques dans la colonne vertébrale lombaire de 60 truies adultes et de 30 porcs ayant atteint le poids de l'abattage. Certains de ceux-ci présentaient de l'asymétrie des facettes articulaires lombaires et des petits ostéophytes péri-articulaires; on n'y retrouva cependant pas de dégénérescence des disques intervertébraux ou d'ostéophytes vertébraux. Par contre, 38% des 60 truies présentaient des ostéophytes vertébraux et 40% présentaient de la dégénérescence des disques intervertébraux; deux d'entre elles souffraient aussi d'une spondylose ankylosante extensive. Les autres lésions vertébrales de ces truies incluaient: de l'asymétrie et de l'arthrose des facettes articulaires, des fissures et des foyers de cavitation, dans l'annulus fibrosus et la plaque vertébrale terminale, ainsi que de l'ostéomyélite et/ou des fractures. Les lésions squelettiques extravertébrales, dont on pouvait relier certaines d'entre elles à une anamnèse de boiterie ou de paralysie postérieure, incluaient: de l'arthrose sacro-iliaque, des difformités pelviennes, de la polyarthrite, de l'ostéomyélite fémorale, des dislocations sacroiliaques et de l'épiphyséolyse qui affectait la tête du fémur ou le tuber ischii.

INTRODUCTION

Locomotory disturbances in growing and breeding-age swine are a significant problem in many parts of the world (3,11,17, 22,27). Although various pathological skeletal changes have been reported (3,4,10-12,27) not all are responsible for clinical lameness (8,26). While most of the skeletal lesions described involve the appendicular skeleton there are only a few reports which document pathological changes other than osteomyelitis involving the vertebral column (1,11-13). This is in contrast to other species (man, dog, bull) where degenerative processes of the vertebral column are common and have been described in detail (2,5-7,9,16,18-21,23,25,28, 29).

The purpose of this study was to identify and describe gross pathological changes found in the lumbar vertebral column of a sample of slaughter weight and breeding-age female swine. Some extravertebral skeletal lesions are described as well.

*Department of Veterinary Pathology, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0.

Submitted September 5, 1978.

MATERIALS AND METHODS

The lumbar vertebral columns from 60 sows and 30 slaughter weight pigs were recovered from a local abattoir and from a veterinary diagnostic laboratory. Specimens were cut longitudinally and examined grossly for pathological changes. Special attention was directed towards intervertebral discs, articular facets and the presence or absence of vertebral osteophytes. In a limited number of cases, coxofemoral joints, sacroiliac joints, the pelvis and the entire vertebral column were also available for examination. All specimens were boiled to remove soft tissues and bleached in 1% hydrogen peroxide. Selected specimens were collected for bacteriology and histopathology. Histopathological findings are not included here but will be reported at a later date.

Only in the case of specimens derived from the diagnostic laboratory was the age of the animal and clinical history available. In these animals, death was due to many different causes. A few had a specific history of lameness. Slaughter weight animals (90 kg) were judged to be five to seven months of age. Abattoir specimens classed as breeding females were animals over 100 kg and the majority was large sows that had had at least one litter. Breeds represented in abattoir material are unknown. Yorkshire, Landrace and Lacombe breeds were represented in animals derived from the diagnostic laboratory.

RESULTS

Slaughter Weight Group

Most pathological changes seen in this group were of a minor nature. Asymmetry of lumbar articular facets and small periarticular osteophytes (Fig. 1) were common findings. Fusion of the bodies of L_{3-4} was observed in one animal. No vertebral osteophytes were found and the only abnormality seen in intervertebral discs was a fracture of the vertebral end plate (T_{13}) with extension of the outer part of the disc into the vertebral epiphysis (Fig. 2). Three animals in this group were sub-

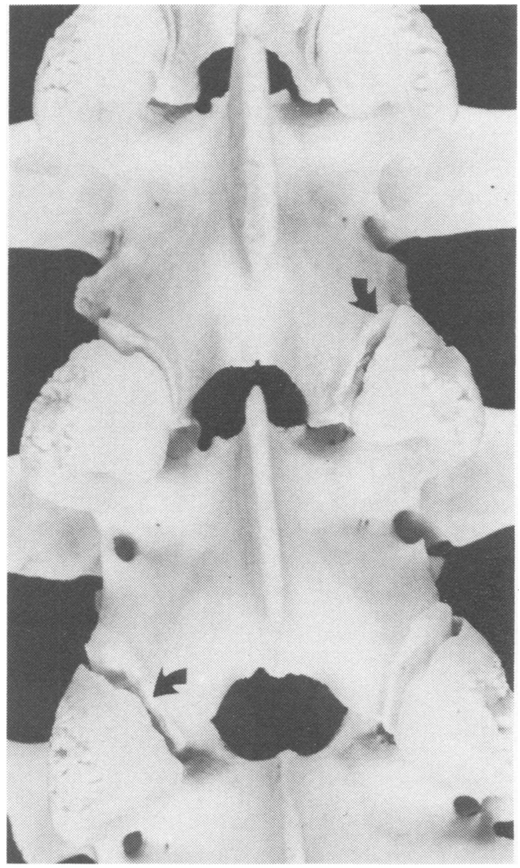

Fig. 1. Dorsal view of lumbar vertebrae (boiled specimen) from a 90 kg pig. Small osteophytes (arrows) are present at the margins of articular facets.

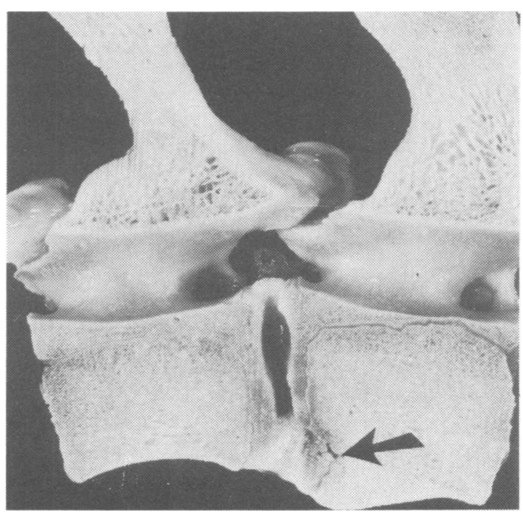

Fig. 2. Midsagittal section of vertebrae (boiled specimen) from a 90 kg pig. There is a fracture (arrow) extending through the vertebral end plate and epiphysis of T_{13}.

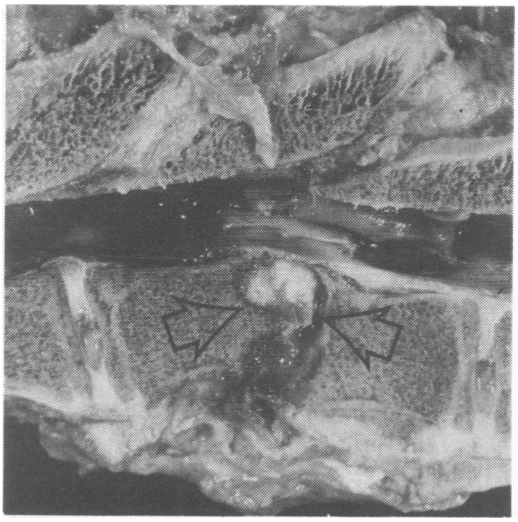

Fig. 3. Vertebral osteomyelitis (arrows) at the level of $T_{8\text{-}9}$ in a 90 kg pig.

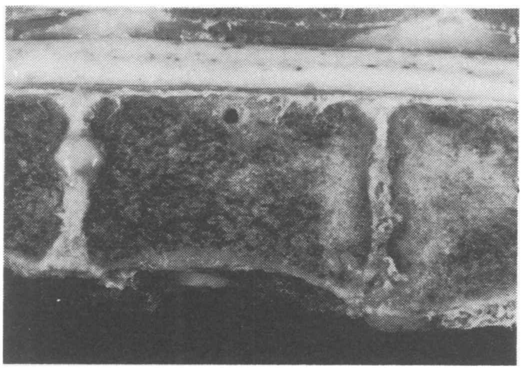

Fig. 4. Midsagittal section through lumbar vertebrae and spinal cord of a mature sow (fresh specimen). The disc on the left appears normal; the disc space on the right is narrow and the disc is degenerate and disrupted. There is a ventral osteophyte and osteosclerosis in the area adjacent to the degenerate disc.

mitted for necropsy with a clinical history of lameness or posterior paralysis. Lesions found in these animals at necropsy included (a) vertebral osteomyelitis ($T_{8\text{-}9}$) with pathological fracture and spinal cord compression (Fig. 3), (b) nonsuppurative polyarthritis and (c) separation of right femoral capital epiphysis plus fracture of the second sacral vertebra and dislocation of the right sacroiliac joint.

Breeding Female Groups

Degeneration of intervertebral discs and the presence of vertebral osteophytes were the most common lesions observed. These lesions were often, but not always, associated one with the other. Although the exact age of animals in this study is not known the incidence of both lesions appeared to increase with age.

Intervertebral discs which were judged to be normal were composed of a central, transparent, gelatinous *nucleus pulposus* which bulged from the cut surface and the *annulus fibrosus* which was white, dense and clearly demarcated from the *nucleus pulposus*. Degenerative changes (seen in 40% of specimens examined) were manifest grossly as narrowing of the intervertebral space and conversion of the *nucleus pulposus* to a dark, friable, sometimes granular mass. In longitudinal sections, the ventral portion of the *annulus fibrosus* was often frayed and discolored. Osteosclerosis involving the bodies and epiphyses of adjacent vertebrae was sometimes seen in association with disc degener-

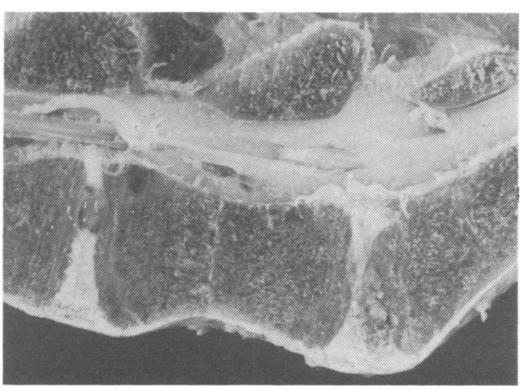

Fig. 5. Midsagittal section through lower lumbar vertebrae (fresh specimen) of a mature sow. The disc on the left is normal; the lumbosacral disc (on the right) has degenerative changes. No osteophytes are present.

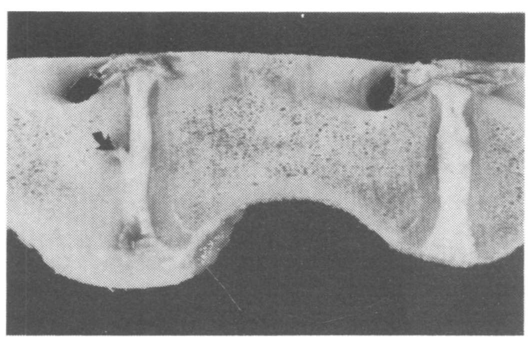

Fig. 6. Midsagittal section through the bodies of lumbar vertebrae (fresh specimen) of a mature sow. The disc space on the left is narrow and the annulus fibrosus extends through the vertebral end plate into cancellous bone. There is osteosclerosis in adjacent areas and a large ventral osteophyte is present. The disc on the right is normal.

ation (Figs. 4 and 5). No evidence of ventral or dorsal herniation of disc material was seen although extension of the *annulus* through small defects in the vertebral end plate was observed (Fig. 6). In one instance, disc degeneration and ventral osteophyte formation were associated with dorsal enlargement of adjacent vertebral epiphyses so that a degree of stenosis of the vertebral canal was produced (Fig. 7). In boiled specimens, focal areas of cavitation in the central or ventral part of the disc and end plate were observed in ten instances (Fig. 8). These were not always associated with vertebral osteophytes. Fissures which extended through the *annulus* and vertebral end plate were observed in three specimens (Fig. 9). No significant bacteria were isolated from ten degenerate discs which were cultured.

Vertebral osteophytes were found in 38% of the specimens examined. The distribution of osteophytes within the lumbar spine is shown in Fig. 10. In an individual animal, these were single or multiple spurs or plaques of dense bone on the lateral and/or ventral surface of vertebrae (Figs. 11 and 12). They were continuous with the bone of the vertebral body and epiphysis and arose from both the cranial and caudal aspect of vertebrae. In the caudal part of the lumbar spine, most arose from the caudal area whereas, in the anterior part, cranial and caudal osteophytes were present in nearly equal proportions. Complete bony bridging between adjacent vertebrae was uncommon although many osteophytes had interdigitating apposing surfaces. Some extended dorsally to encroach on intervertebral foramina (Fig. 11) but none projected dorsally into the vertebral canal.

Two animals had extensive new bone formation on the vertebral periosteal surfaces which led to bony ankylosis of vertebral bodies and articular facets (Fig. 13). One animal (known to be six years old) was submitted for necropsy with a history of an acute onset posterior paralysis and a fracture through L_3 was found at necropsy. The second animal had similar but less extensive lesions.

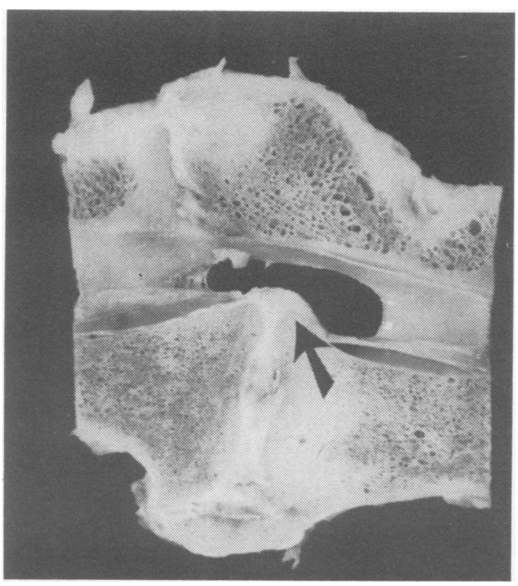

Fig. 7. Midsagittal section through the second and third lumbar vertebrae of a mature sow. There is disc degeneration and a large osteophyte is present ventrally. Vertebral epiphyses have enlarged dorsally (arrow) so that some stenosis of the vertebral canal is present.

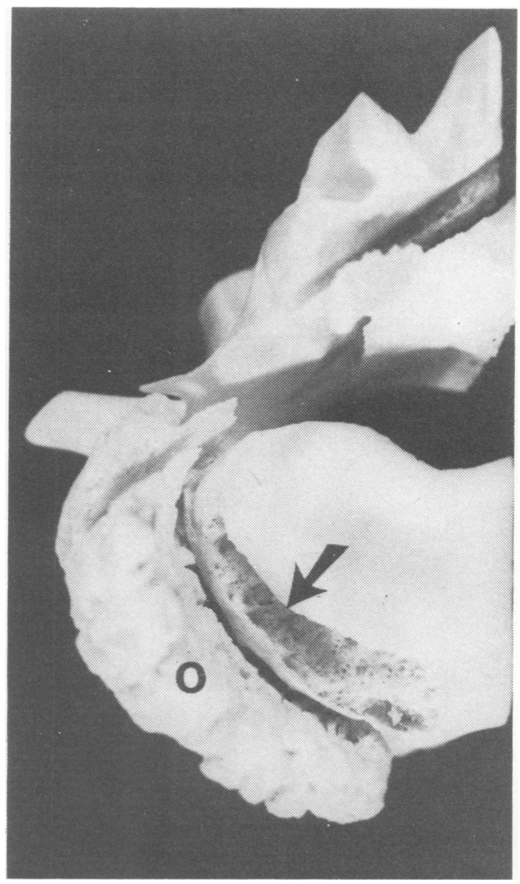

Fig. 8. Posterior view of the second lumbar vertebra (boiled specimen) from a mature sow. There is a large area of cavitation (arrow) in the annulus fibrosus and the vertebral end plate. A large, ventrolateral osteophyte (0) is present.

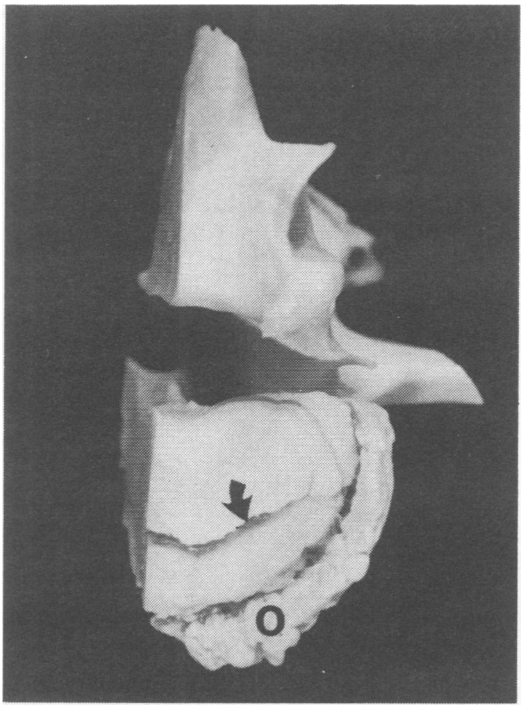

Fig. 9. Posterior view of a hemi-section of the fifth lumbar vertebra (boiled specimen) from a mature sow. There is a fissure (arrow) in the annulus fibrosus and vertebral end plate. A large, ventrolateral osteophyte (0) is present.

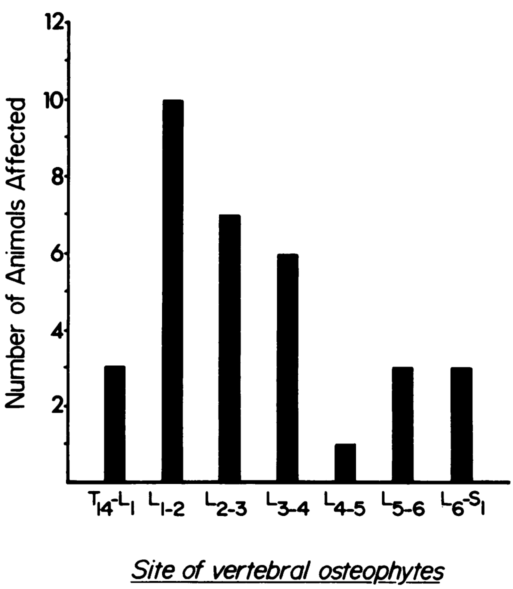

Fig. 10. Distribution of osteophytes in the lumbar spine of sixty breeding-age female swine.

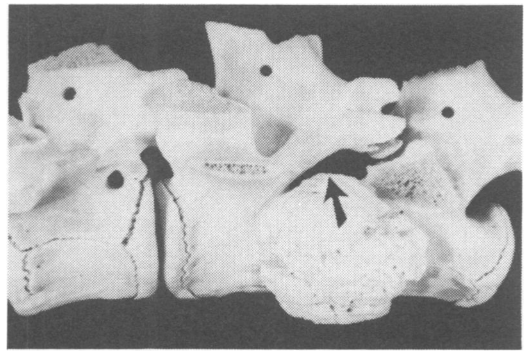

Fig. 11. Lateral view of lumbar vertebrae (boiled specimen) from a mature sow. A large osteophyte at L_{4-5} projects dorsolaterally (arrow) to narrow the intervertebral foramina.

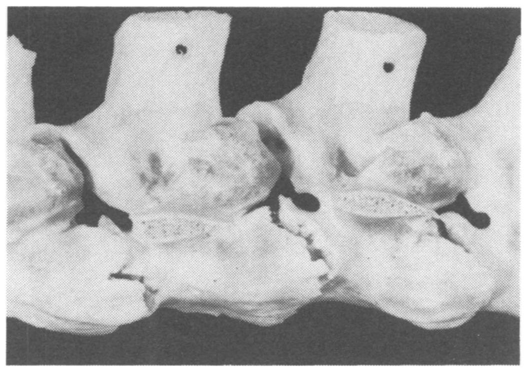

Fig. 12. Lateral view of lumbar vertebrae (boiled specimen) from a mature sow. There are multiple, ventrolateral, interdigitating osteophytes.

Asymmetry of lumbar articular facets, as in the case of slaughter weight animals, was a common finding that was not necessarily associated with other pathological changes. Cartilage of some articular facets was dull, yellowish in color and had small, linear, surface defects. Small periarticular osteophytes which projected (minimally) into the vertebral canal were also seen (Fig. 14).

Five sows had a clinical history of lameness and/or posterior paralysis. Lesions found in these animals include (a) fracture of L_6 with displacement and spinal cord compression, (b) bilateral separation of femoral capital epiphyses, (c) femoral osteomyelitis, (d) ankylosing spondylosis, fracture of L_3 and sacroiliac arthrosis (Fig 15) and (e) osteomyelitis of the proximal femur and sacroiliac joint area.

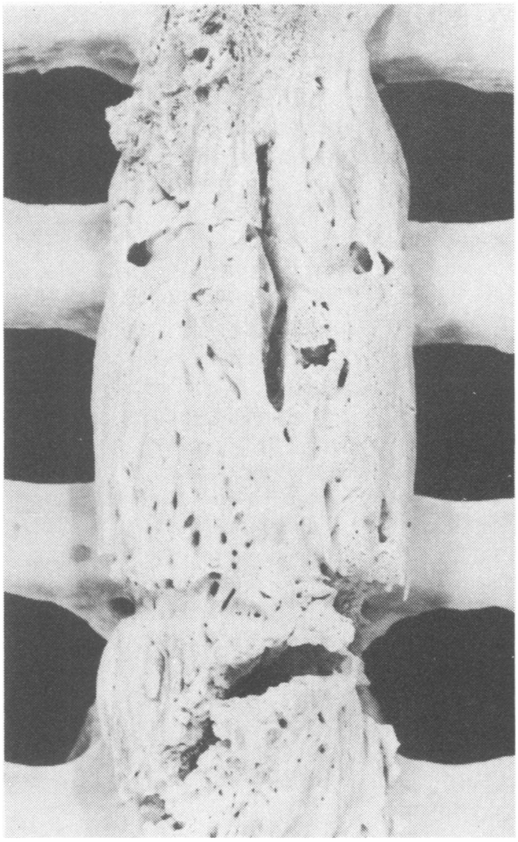

Fig. 13. View of the ventral aspect of lumbar vertebrae (boiled specimen) from a six year old sow. There is extensive ankylosing spondylosis.

Other lesions found in sows where no clinical history was available include (a) pelvic deformity (Fig. 16), (b) osteophytes on surface of *tuber ischii* (two cases), (c) avulsion fracture through epiphyses of *tuber ischii* and (d) separation of femoral capital epiphysis.

DISCUSSION

Intervertebral articulations represent a three joint complex which consists of the intervertebral disc and the dorsally located, paired, articular facets. These joints provide for movement, and stress on one is likely to produce stress on the other (29). The normal intervertebral disc is a fibrocartilaginous structure which consists of the *nucleus pulposus* which resists and redistributes compressive forces and the surrounding *annulus fibrosus* which is composed of fibrous lamellae. The latter structure withstands tension and serves to unite vertebral bodies (21). Articular processes stabilize the intervertebral joints against torsion (7). The functional integrity of the *nucleus pulposus* relates to its high content of protein polysaccharide and to its abililty to retain water (21). Gross degenerative changes such as dehydration and disruption of the disc, narrowing of

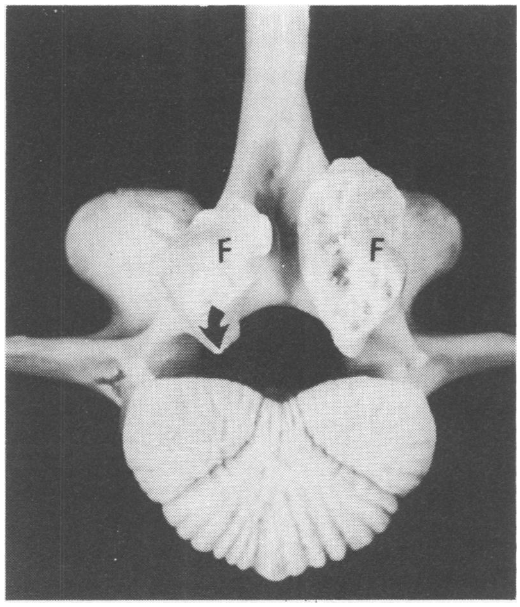

Fig. 14. View of the posterior surface of a lumbar vertebra (boiled specimen) from a sow. Articular facets (F) are asymmetrical, and marginal osteophytes (arrow) project into the vertebral canal.

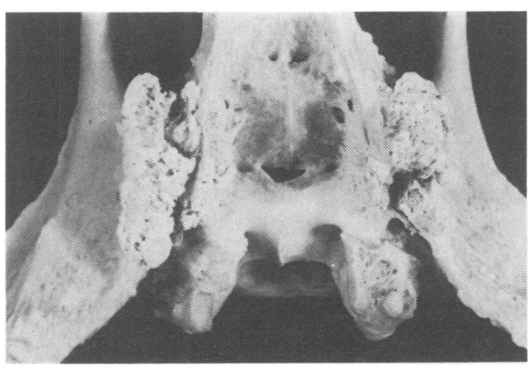

Fig. 15. Dorsal view of sacroiliac joints (boiled specimen) from a mature sow. Massive osteophytes are present at the margin of joints.

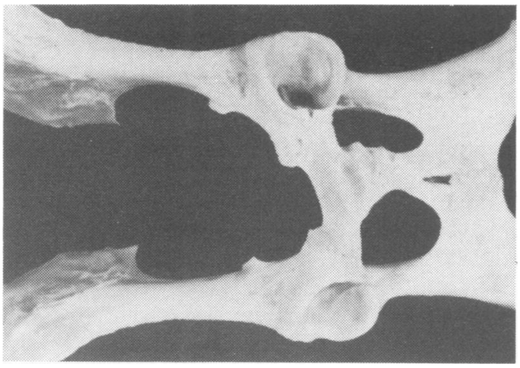

Fig. 16. View of ventral surface of the pelvis (boiled specimen) of a sow. Note the deformity and asymmetry present.

the intervertebral space and fraying and discoloration of the *annulus* as seen in this study resemble changes previously reported in the pig (11,13) and in other species (2,5,18,25,29). Dorsal herniation of disc material as seen in the dog and in man was not seen in animals included in this study. Defects in vertebral end plates with extension of disc components into the vertebral epiphysis were seen in both age groups. Similar lesions have been reported in the bull (25), in man and in the pig (12) and it has been hypothesized that this lesion may lead to or hasten the process of degeneration of intervertebral discs (23).

The literature relating to the etiology and pathogenesis of degeneration of intervertebral discs is voluminous and, in some cases, contradictory. Some of the factors thought to play a role in initiating degeneration of intervertebral discs in man include normal aging (28), rotary and compressive mechanical injury (7), abnormal lordotic posture (5), scoliosis, asymmetry of articular facets (28) and poorly coorlinated muscle action (29). In man and other species, normal aging commonly leads to the gradual loss of the gel-like properties of the *nucleus pulposus* and to gradual fibrocartilaginous metaplasia in the *annulus fibrosus* (2). These changes plus mechanical stress may lead to concentric or radical tears in the *annulus* which, in turn, may permit herniation of disc contents. Fissures and focal areas of cavitation in the *annulus* and vertebral end plates were seen in this study but none extended dorsally towards the vertebral canal. Farfan (6) has reported that the shape of the intervertebral disc determines the site and direction of radial tears in the *annulus* that are produced by rotational-type injury. In human discs with an indented posterior outline stress concentrations and tears occur lateral to the pedicles, whereas in discs with a rounded posterior outline stress is concentrated in the midline and therefore favours midline herniation of disc material. The fact that the outline of the lumbar disc in the pig is indented may explain why dorsal fissures or dorsal herniation of disc material rarely, if ever, occurs.

In regard to the pathogenesis of intervertebral disc degeneration it has been reported (23) that maintenance of fluid in the *nucleus pulposus* depends on the integrity of the cartilagenous end plate and that thinning, ossification and/or disruption of the end plate may lead to reduced volume of the *nucleus pulposus*, increased stress on the *annulus* and further degenerative changes. While defects in vertebral end plates were seen in this study, they were not always accompanied by disc degeneration. Some human patients have a chronic inflammatory process associated with disc degeneration and it has been hypothesized that this inflammation may have an auto-immune basis (9).

The cause of degeneration of intervertebral discs in swine is not known. Some of the theories advanced in human medicine may apply although one must recognize that vertebral anatomic structure, posture and mechanical forces acting on the lumbar spine are not identical in man and in the pig. Abnormal lordotic posture, asymmetrical articular facets (a common finding in this study) and rotational-type stress could be important in swine although lumbar articular facets in swine are aligned in such a way that little lumbar rotation seems possible.

Vertebral osteophytes may occur alone or may be associated with degeneration of intervertebral discs and/or arthrosis of articular facets (6,18). They have also been described in association with erysipelas and *Brucella* discospondylitis (10, 15,24). Many of the osteophytes seen in this study were associated with disc degeneration. The terms, spondylosis or spondylosis deformans, have been used by others to describe similar lesions and seem appropriate (1,19,25). The incidence of osteophytes found in this study (38%) is comparable to figures (31% and 46%) reported by others (1,12). All osteophytes arising from the vertebral bodies were lateral and/or ventral and none protruded into the vertebral canal as occurs in man (20). Although some caused narrowing of intervertebral foramina, compression of nerves or blood vessels was not demonstrated.

Two sows had extensive new bone formation on the outer periosteal surface of vertebrae. In one animal, this led to a pathological fracture as occurs in bulls (25). This new bone formed a sleeve which united the circumference of articular facets and the space between vertebral bodies. True bony ankylosis (bone formation across joint spaces) was not seen. Although these lesions were not examined microscopically, they were judged to be noninfectious in origin since true bony ankylosis, discospondylitis and chronic polyarthritis as described (10,24) in association with disease due to *Erysipelothrix insidiosa* were not seen. It should be noted that *Brucella* spondylitis is characterized by narrowing of the disc space, vertebral osteophytes and lytic defects in vertebral bodies (15).

In man, vertebral osteophytes occur most commonly in the normal concavities of the spine and the incidence increases with age (30). Their occurrence has been related to degeneration of intervertebral discs and failure of the disc to transmit forces uniformly to the vertebral end plates. In the bull, osteophytes have been attributed to degeneration of the *annulus*, impaired disc function and abnormal movement between vertebral bodies (25). Morgan (18), in a study of vertebral osteophytes in dogs, found that the disc space at the level of the osteophyte was usually of normal width. He reported that stress, degeneration and avulsion of the attachments of outer fibers of the *annulus*, rather than changes in the *nucleus pulposus*, were important in the evolution of vertebral osteophytes. Experimentally, in the dog, injury to the ventral longitudinal ligament and/or the ventral *annulus* leads to osteophyte formation (18).

Asymmetry and arthrosis of lumbar articular facets were common in adult female swine. In man the former is believed to predispose the disc to rotational type injury (6). Although loss of disc thickness has been reported to lead to degeneration of articular facets due to overriding and instability (29), arthrosis seen in this study was not restricted to areas of disc degeneration.

Lesions such as disc degeneration, vertebral osteophytes and lumbar facet arthrosis may be asymptomatic (18,20). However, they may produce clinical signs in a number of ways.

Disc degeneration and loss of disc thickness may lead to progressive degeneration and enlargement of articular facets (16). Facet arthrosis may be accompanied by swelling of the synovium, facet enlargement and marginal osteophytes which may cause stenosis of the vertebral canal (29). Radial tears in the *annulus* opens avenues for disc herniation and compression of spinal nerves and/or the spinal cord. Pain, associated with disc degeneration may be due to mechanical distortion of the outer *annulus* or tension on longitudinal ligaments and surrounding connective tissue (21). Pain due to compression of spinal nerves or due to fracture of the vertebral end plate may be referred to the extremities (6). Vertebral osteophytes, often considered of questionable clinical significance, have the potential to cause stenosis of the vertebral canal or of intervertebral foramina (20). Impaired ability to mount and susceptibility to vertebral fracture has been reported in the bull (25). The significance of the lesions seen in the lumbar vertebral column in this study is uncertain due to a lack of clinical history in most animals. Only one animal was known to have a clinical history which could clearly be related to lesions in the lumbar spine. However, many adult sows have abnormalities in locomotion, often not of a crippling degree, which account for their being culled from the herd. These sows have a limited range of movement and have difficulty rising. The described degenerative changes in the vertebral column could be, at least in part, responsible.

Most of the extravertebral skeletal lesions reported here have been described previously (4,12,14). The deformity of the pelvis seen in a single specimen was judged to be secondary to osteomalacia which had occurred at a previous date. The cause of the severe arthrosis of the sacroiliac joint in one animal is unknown.

Even from this small sample of animals, it is clear that the problem of locomotory disturbances in swine is complex and is not a single pathological or etiological entity.

ACKNOWLEDGMENTS

This work was supported financially by the National Research Council of Canada.

I wish to thank Miss Jackie McKnight for typing the manuscript and Mrs. Susan Wales and Mr. Guenther Appl for their technical assistance.

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